

CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: September 24, 2019

FILE REF: 3200

TO: Sheri Snowbank, NOR – Spooner Service Center

FROM: Wade Strickland – WY/3

SUBJECT: Water Quality-Based Effluent Limitations for the City of Mellen
WPDES Permit No. WI-0020311

This is in response to your request for an evaluation of the need for water quality-based effluent limitations using Chapters NR 102, 104, 105, 106, 207, 210, 212, and 217 of the Wisconsin Administrative Code (where applicable), for the discharge from the City of Mellen wastewater treatment facility (WWTF) in Ashland County. This municipal WWTF discharges to the Bad River, located in the Upper Bad River Watershed in the Lake Superior Drainage Basin. The evaluation of the permit recommendations is discussed in more detail in the attached report.

Based on our review, the following recommendations are made on a chemical-specific basis at outfall 001:

Parameter	Daily Maximum	Daily Minimum	Weekly Average	Monthly Average	Footnotes
BOD ₅			45 mg/L	30 mg/L	1,2
TSS			45 mg/L	30 mg/L	1
pH	9.0 s.u.	6.0 s.u.			1
Ammonia Nitrogen	Variable				5,7
April – May			47 mg/L	32 mg/L	
June – September			108 mg/l	89 mg/L	
October – March			54 mg/L	37 mg/L	
Fecal Coliforms			656#/100 mL	400#/100 mL	5
May – September			geometric mean	geometric mean	
Mercury			1.3 ng/L	1.3 ng/L	4,5
Phosphorus					3
Temperature, Max					3
Sulfates					5

Footnotes:

1. No changes from the current permit
2. CBOD₅ limits may be included in the permit instead of BOD₅ limits if adequate CBOD₅/BOD₅ sampling is provided. Per s. NR 210.07(4), the facility would need to sample in January and July. Additionally, nitrogen sampling might also be required if NBOD concentrations consistently exceed 5 mg/L. If the conditions in s. NR 210.07(4) for CBOD₅ limits are met, the weekly average would be set to 40 mg/L and the monthly average would be set to 25 mg/L per NR 210.05(1)(d).
3. Monitoring only in the fourth year of the permit term
4. This is the water quality-based effluent limitation for mercury. If this limit is included in the permit, a mass limit would also need to be included. An alternative effluent limitation of 6.5 ng/L, equal to the 1-day P₉₉ of representative data, as a daily maximum may be included in the permit in place of the water quality-based effluent limit if the mercury variance application that was submitted is approved by EPA.

5. Additional limits to comply with the expression of limits requirements in ss. NR 106.07 and NR 205.065(7) are included in bold
6. Monitoring only
7. The variable daily maximum ammonia nitrogen limit table corresponding to various effluent pH values may be included in the permit in place of the single daily maximum limit of 9.4 mg/L. if the single limit is used the weekly and monthly average limits would also be 9.4 mg/L. These limits apply year-round.

Daily Maximum Ammonia Nitrogen Limits – Cold Water Category 5

Effluent pH s.u.	Limit mg/L	Effluent pH s.u.	Limit mg/L	Effluent pH s.u.	Limit mg/L
6.0 < pH ≤ 6.1	108	7.0 < pH ≤ 7.1	66	8.0 < pH ≤ 8.1	14
6.1 < pH ≤ 6.2	106	7.1 < pH ≤ 7.2	59	8.1 < pH ≤ 8.2	11
6.2 < pH ≤ 6.3	104	7.2 < pH ≤ 7.3	52	8.2 < pH ≤ 8.3	9.4
6.3 < pH ≤ 6.4	101	7.3 < pH ≤ 7.4	46	8.3 < pH ≤ 8.4	7.8
6.4 < pH ≤ 6.5	98	7.4 < pH ≤ 7.5	40	8.4 < pH ≤ 8.5	6.4
6.5 < pH ≤ 6.6	94	7.5 < pH ≤ 7.6	34	8.5 < pH ≤ 8.6	5.3
6.6 < pH ≤ 6.7	89	7.6 < pH ≤ 7.7	29	8.6 < pH ≤ 8.7	4.4
6.7 < pH ≤ 6.8	84	7.7 < pH ≤ 7.8	24	8.7 < pH ≤ 8.8	3.7
6.8 < pH ≤ 6.9	78	7.8 < pH ≤ 7.9	20	8.8 < pH ≤ 8.9	3.1
6.9 < pH ≤ 7.0	72	7.9 < pH ≤ 8.0	17	8.9 < pH ≤ 9.0	2.6

Please consult the attached report for details regarding the above recommendations. If there are any questions or comments, please contact Diane Figiel at (608) 264-6274 or Diane.Figiel@wisconsin.gov.

Attachments (2) – Narrative & Map

PREPARED BY: John Dougherty and Diane Figiel

APPROVED BY: _____ Date: _____
Diane Figiel, PE,
Water Resources Engineer

E-cc: Eric de Venecia, Wastewater Engineer – NOR, Superior Service Center
Michelle Balk, Regional Wastewater Supervisor – Spooner Service Center

Water Quality-Based Effluent Limitations for the City of Mellen

WPDES Permit No. WI-0020311-09-2

Prepared by: John Dougherty and Diane Figiel

PART 1 – BACKGROUND INFORMATION

Facility Description: The City of Mellen wastewater treatment facility operates two aerated lagoons that operate with a new fine bubble diffuser, a fine screen system, and UV disinfection system prior to discharge into the Bad River.

Attachment #2 is a USGS topographic map of the area showing the approximate location of Outfall 001.

Existing Permit Limitations: The current permit which expired on September 30, 2018, includes the following effluent limitations.

Parameter	Daily Maximum	Daily Minimum	Weekly Average	Monthly Average	Footnotes
BOD ₅			45 mg/L	30 mg/L	1
TSS			45 mg/L	30 mg/L	1
pH	9.0 s.u.	6.0 s.u.			1
Ammonia Nitrogen	Variable				
Fecal Coliforms May – September				400#/100 mL geometric mean	1
Mercury					3
Phosphorus, Total					2
Sulfate, Total					2

Footnotes:

- These limitations are not being evaluated as part of this review. Because the water quality criteria (WQC), reference effluent flow rates, and receiving water characteristics have not changed, limitations for these water quality characteristics do not need to be re-evaluated at this time.
- Monthly monitoring only
- Quarterly sampling only
- The variable daily maximum limit for ammonia follows the table below:

Effluent pH	Daily Limit	Effluent pH	Daily Limit	Effluent pH	Daily Limit
7.5* < pH ≤ 7.6	34 mg/L	8.0 < pH ≤ 8.1	14 mg/L	8.5 < pH ≤ 8.6	5.3 mg/L
7.6 < pH ≤ 7.7	29 mg/L	8.1 < pH ≤ 8.2	11 mg/L	8.6 < pH ≤ 8.7	4.4 mg/L
7.7 < pH ≤ 7.8	24 mg/L	8.2 < pH ≤ 8.3	9.4 mg/L	8.7 < pH ≤ 8.8	3.7 mg/L
7.8 < pH ≤ 7.9*	20 mg/L	8.3 < pH ≤ 8.4	7.8 mg/L	8.8 < pH ≤ 8.9	3.1 mg/L
7.9 < pH ≤ 8.0	17 mg/L	8.4 < pH ≤ 8.5	6.4 mg/L	8.9 < pH ≤ 9.0	2.6 mg/L

* Summer (May through October) – a maximum 20 mg/L limit. (Report > 20 mg/L as the daily maximum variable limit when pH is ≤ 7.8 s.u.). Winter (November through April) – a maximum 40 mg/L limit (Report > 34 mg/L as the daily maximum variable limit when pH is ≤ 7.5 s.u.)

Receiving Water Information:

- Name: Bad River
- Classification: Cold water sport fish community, non-public water supply. (Cold water and Public Water Supply criteria would be used for bioaccumulating compounds of concern, because the discharge is within the Great Lakes basin.) Cold water category 5 for ammonia nitrogen.
- Low Flow: The following 7-Q₁₀ and 7-Q₂ values are from USGS station located at NW ¼, NE ¼, SEC. 6, T44N-R2W, Ashland County at highway 13, in Mellen, WI. The Harmonic Mean has been estimated as recommended in *State of Wisconsin Water Quality Rules Implementation Plan* (Publ. WT-511-98)
 - 7-Q₁₀ = 5.4 cfs (cubic feet per second)
 - 7-Q₂ = 12 cfs
 - 90-Q₁₀ = 10.20 cfs
 - Harmonic Mean Flow = 23.33 cfs using a basin area of 100.0 mi²
- Hardness = 58 mg/L as CaCO₃. This value represents the geometric mean of data from 61 results from a monitoring location at USH 2 near Odanah, WI on the Bad River, downstream of the City of Mellen.
- % of low flow used to calculate limits: 25%
- Source of background concentration data: Metals data from two monitoring sites along the Bad River are used for this evaluation. For all arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc, background concentrations were gathered from a monitoring site on the Bad River at Gilman Park, just upstream of the City of Mellen discharge. For chloride, background concentrations were taken from the monitoring site at Gilman Park in addition to a monitoring site downstream at USH 2 near Odanah, WI. The numerical values are shown in the tables below.
- Multiple dischargers: None
- Impaired water status: The Bad River and downstream waters are not listed as impaired for any pollutants.

Effluent Information:

- Design Flow Rate(s):
 - Annual average = 0.205 MGD (Million Gallons per Day)
 - For reference, the actual average flow from April 2013 to April 2018 was 0.201 MGD. Average flows for the months of April and May over the past five years are 0.260 MGD and 0.326 MGD respectively.
- Hardness = 230 mg/L as CaCO₃. This value represents the geometric mean of data from four samples taken between 03/26/2018 to 04/05/2018 from their permit reissuance application.
- Acute dilution factor used: Not applicable – this facility does not have an approved Zone of Initial Dilution (ZID).
- Water Source: Mellen Municipal Utilities
- Additives: None at WWTF
- Effluent characterization: This facility is categorized as a minor municipality, so the permit application required effluent sample analyses for a limited number of common pollutants, primarily metal substances plus Ammonia, Chloride, Hardness and Phosphorus.

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Sample Date	Copper µg/L	Sample Date	Copper µg/L	Sample Date	Copper µg/L
03/01/2018	20.2	03/15/2018	24.7	03/29/2018	25.2
03/05/2018	19.7	03/19/2018	23.2	04/02/2018	23.8
03/08/2018	22.4	03/22/2018	26.6	04/05/2018	21.1
03/12/2018	22.3	03/26/2018	24.2		
1-day P ₉₉ = 28.5 µg/L					
4-day P ₉₉ = 25.6 µg/L					

Sample Date	Chloride mg/L
03/26/2018	290
03/29/2018	290
04/02/2019	280
04/05/2019	270
Mean	282.5

Mercury	Field Blank ng/L	Outfall 002 ng/L
10/09/2014	<0.14	1.41
02/11/2015	3.17	3.98*
06/10/2015	1.24	0.14*
08/13/2015	0.118	1.13
11/04/2015	<0.102	1.53
01/27/2016	0.136	4.07
04/27/2016	<0.14	2.67
09/14/2016	<0.14	0.824
12/27/2016	<0.14	3.28
03/24/2017	0.167	3.6
06/07/2017	0.142	2.03
08/30/2017	<0.14	3.84
11/14/2017	<0.13	3.55
1-day P ₉₉		6.50
4-day P ₉₉		4.24
30-day P ₉₉		3.09

*Result was not used in the calculation due to high field blank

Effluent data for substances for which a single sample was analyzed is shown in the tables in Part 2 below, in the column titled "MEAN EFFL. CONC.".

The following table presents the average concentrations and loadings at Outfall 001 from April 2013 to April 2018 for all parameters with limits in the current permit to meet the requirements of s. NR 201.03(6):

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	Average
BOD ₅	11.6 mg/L
TSS	9.3 mg/L
pH field	7.6 s.u.
Phosphorus	1.2 mg/L
Ammonia Nitrogen	6.4 mg/L
Sulfates	16.0 mg/L
Mercury	2.5 ng/L

PART 2 – WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR TOXIC SUBSTANCES – EXCEPT AMMONIA NITROGEN

In general, permit limits for toxic substances are recommended whenever any of the following occur:

1. The maximum effluent concentration exceeds the calculated limit (s. NR 106.05(3), Wis. Adm. Code)
2. If 11 or more detected results are available in the effluent, the upper 99th percentile (or P₉₉) value exceeds the comparable calculated limit (s. NR 106.05(4), Wis. Adm. Code)
3. If fewer than 11 detected results are available, the mean effluent concentration exceeds 1/5 of the calculated limit (s. NR 106.05(6), Wis. Adm. Code)

Acute Limits based on 1-Q₁₀

Daily maximum effluent limitations for toxic substances are based on the acute toxicity criteria (ATC), listed in ch. NR 105, Wis. Adm. Code. Previously daily maximum limits for toxic substances were calculated as two times the ATC. However, changes to ch. NR 106, Wis. Adm. Code (September 1, 2016) require the Department to calculate acute limitations using the same mass balance equation as used for other limits along with the 1-Q₁₀ receiving water low flow to determine if more restrictive effluent limitations are needed to protect the receiving stream from discharges which may cause or contribute to an exceedance of the acute water quality standards.

$$\text{Limitation} = \frac{(\text{WQC}) (Q_s + (1-f) Q_e) - (Q_s - f Q_e) (C_s)}{Q_e}$$

Where:

WQC = Acute toxicity criterion or secondary acute value according to ch. NR 105

Q_s = average minimum 1-day flow which occurs once in 10 years (1-day Q₁₀)

if the 1-day Q₁₀ flow data is not available = 80% of the average minimum 7-day flow which occurs once in 10 years (7-day Q₁₀).

Q_e = Effluent flow (in units of volume per unit time) as specified in s. NR 106.06(4)(d)

f = Fraction of the effluent flow that is withdrawn from the receiving water, and

C_s = Background concentration of the substance (in units of mass per unit volume) as specified in s. NR 106.06(4)(e).

As a rule of thumb, if the receiving water is effluent dominated under low stream flow conditions, the 1-Q₁₀ method of limit calculation produces the most stringent daily maximum limitations and should be used while making reasonable potential determinations.

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The following tables list the water quality-based effluent limitations for this discharge along with the results of effluent sampling for all the detected substances. All concentrations are expressed in term of micrograms per Liter ($\mu\text{g/L}$), except for hardness and chloride (mg/L) and mercury (ng/L).

Daily Maximum Limits based on Acute Toxicity Criteria (ATC)

RECEIVING WATER FLOW = 4.32 cfs, (1- Q_{10} (estimated as 80% of 7- Q_{10})).

SUBSTANCE	REF. HARD.* mg/L	ATC	MEAN BACK-GRD.	MAX. EFFL. LIMIT**	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.	1-day P_{99}	1-day MAX. CONC.
Arsenic		340	0.71	679.6	135.9	7.0		
Cadmium	230	11.3	0.02	22.7	4.5	< 0.30		
Chromium	230	3567	0.64	7133.3	1427	< 5.0		
Copper	230	34.1	1.31	68.1			28.50	26.6
Lead	230	239	0.28	478.2	95.6	< 1.4		
Mercury (ng/L)		830	4.87	830			6.50	4.07
Nickel	230	949	0.79	1898.4	380	19.1		
Zinc	230	249	3.45	498.8	99.8	31.0		
Chloride (mg/L)		757	3.79	1514	303	282.5		

* The indicated hardness may differ from the effluent hardness because the effluent hardness exceeded the maximum range in ch. NR 105 over which the acute criteria are applicable. In that case, the maximum of the range is used to calculate the criterion.

** The 2 x ATC method of limit calculation yields a more restrictive limit than consideration of ambient concentrations and 1- Q_{10} flow rates per the changes to s. NR 106.07(3), Wis. Adm. Code, effective 09/01/2016.

Weekly Average Limits based on Chronic Toxicity Criteria (CTC)

RECEIVING WATER FLOW = 1.35 cfs ($\frac{1}{4}$ of the 7- Q_{10})

SUBSTANCE	REF. HARD. mg/L	CTC	MEAN BACK-GRD.	WEEKLY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.	4-day P_{99}
Arsenic		148.0	0.71	775	155.0	7.0	
Cadmium	58	1.61	0.02	8.39	1.7	< 0.30	
Chromium	58	55.18	0.64	287	57.5	< 5.0	
Copper	58	6.49	1.31	28.5			25.60
Lead	58	16.55	0.28	85.8	17.2	< 1.4	
Mercury (ng/L)		440	4.87	440			4.24
Nickel	58	32.92	0.79	170	33.9	19.10	
Zinc	58	74.76	3.45	378	75.7	31.0	
Chloride (mg/L)		395	3.79	2060	412.0	282.5	

Monthly Average Limits based on Wildlife Criteria (WC)

RECEIVING WATER FLOW = 2.55 cfs ($\frac{1}{4}$ of the 90- Q_{10})

SUBSTANCE	WC	MEAN BACK-GRD.	MO'LY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.	30-day P_{99}
Mercury (ng/L)	1.3	4.87	1.30			3.10

Monthly Average Limits based on Human Threshold Criteria (HTC)

RECEIVING WATER FLOW = 5.83 cfs (¼ of the Harmonic Mean)

SUBSTANCE	HTC	MEAN BACK- GRD.	MO'LY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.
Cadmium	370	0.02	7173	1434.7	< 0.30
Chromium (+3)	3818000	0.64	74025466	14805093	< 5.0
Lead	140	0.28	2709	541.9	< 1.4
Nickel	43000	0.79	833693	166739	19.1

Monthly Average Limits based on Human Cancer Criteria (HCC)

RECEIVING WATER FLOW = 5.83 cfs (¼ of the Harmonic Mean)

SUBSTANCE	HCC	MEAN BACK- GRD.	MO'LY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.
Arsenic	13.3	0.71	244.9	48.97	7.0

In addition to evaluating the need for limits for each individual substance for which HCC exist, s. NR 106.06(8) requires the evaluation of the cumulative cancer risk. Because only one substance for which Human Cancer Criteria exists was detected, determination of the cumulative cancer risk is not needed per s. NR 106.06(8), Wis. Adm. Code.

Conclusions and Recommendations: Based on a comparison of the effluent data and calculated effluent limitations, effluent limitations are apparently needed for mercury.

Mercury – The water quality-based effluent limit for total recoverable mercury is set equal to the most stringent criterion of 1.3 ng/L because the background concentration in the receiving water and similar inland streams is known to exceed 1.3 ng/L.

The 30-day P₉₉ of representative data is 3.09 ng/L, which is greater than the most stringent limit (wildlife criterion of 1.3 ng/L); therefore, **a limit is recommended for mercury.**

In the absence of a variance, a limit of 1.3 ng/L as a monthly average would apply. If a variance is granted and approved by US Environmental Protection Agency, in accordance with s. NR 106.145(5), Wis. Adm. Code, an alternative limit for mercury would be set equal to the upper 99th percentile of daily concentrations, or 1-day P₉₉, and would be expressed as a daily maximum. Accordingly, if a variance is granted, the alternative mercury limit would be **6.5 ng/L, daily maximum.** In conjunction with an alternative limit, the proposed permit shall also include a pollutant minimization program in accordance with s. NR 106.145(6), Wis. Adm. Code.

PART 3 – WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR AMMONIA NITROGEN

The State of Wisconsin promulgated revised water quality standards for ammonia nitrogen effective

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March 1, 2004 which includes criteria based on both acute and chronic toxicity to aquatic life. The current permit has daily maximum, weekly average and monthly average limits for Outfall 001 (calculated in 2012). These limits are re-evaluated at this time due to the following changes:

- Updates to subchapter IV of ch. NR 106, Wis. Adm. Code allow limits based on available dilution instead of limits set to twice the acute criteria.
- Seasonal 20 and 40 mg/L thresholds for ammonia limits are no longer applicable under current rules.

Daily Maximum Limits based on Acute Toxicity Criteria (ATC):

Daily maximum limitations are based on acute toxicity criteria, which are a function of the effluent pH and the receiving water classification. The acute toxicity criterion (ATC) for ammonia is calculated using the following equation.

$$\text{ATC in mg/L} = [A \div (1 + 10^{(7.204 - \text{pH})})] + [B \div (1 + 10^{(\text{pH} - 7.204)})]$$

Where:

A = 0.411 and B = 58.4 for a Cold water Category 5 fishery
pH (s.u.) = that characteristic of the effluent.

The effluent pH data for the past five years was examined as part of this evaluation. A total of 259 sample results were reported from May 2014 through April 2019. The maximum reported value was 8.74 s.u. (Standard pH Units), and a pH of greater than 8.27 s.u. was reported three times. Ninety-nine percent of the time the pH was 8.27 s.u. or less. The 1-day P₉₉, calculated in accordance with s. NR 106.05(5), is 8.53 s.u. And the mean plus the standard deviation multiplied by a factor of 2.33, an estimate of the upper ninety ninth percentile for a normally distributed dataset, is 8.49 s.u. A value of 8.3 s.u. is believed to represent the maximum reasonably expected pH, and therefore most appropriate for determining daily maximum limitations for ammonia nitrogen. Substituting a value of 8.3 s.u. into the equation above yields an ATC = 4.7 mg/L.

Potential changes to daily maximum Ammonia Nitrogen effluent limitations:

Updates to subchapter IV of ch. NR 106, Wis. Adm. Code (effective September 1, 2016) outline the option for the Department to implement use of the 1-Q₁₀ receiving water low flow to calculate daily maximum ammonia nitrogen limits if it is determined that the previous method of acute ammonia limit calculation (2×ATC) is not sufficiently protective of the fish and aquatic life. The more restrictive calculated limits would apply.

The calculated daily maximum ammonia nitrogen effluent limits using the mass balance approach with the 1-Q₁₀ (estimated as 80 % of 7-Q₁₀) and the 2×ATC approach are shown below.

	Ammonia Nitrogen Limit mg/L
2×ATC	9.4
1-Q ₁₀	68.4

The 2×ATC method yields the most stringent limits for Mellen.

The current permit has variable daily maximum effluent limits based on effluent pH. Presented below is a table of daily maximum limitations corresponding to various effluent pH values.

Daily Maximum Ammonia Nitrogen Limits – Cold Water Category 5

Effluent pH s.u.	Limit mg/L	Effluent pH s.u.	Limit mg/L	Effluent pH s.u.	Limit mg/L
6.0 < pH ≤ 6.1	108	7.0 < pH ≤ 7.1	66	8.0 < pH ≤ 8.1	14
6.1 < pH ≤ 6.2	106	7.1 < pH ≤ 7.2	59	8.1 < pH ≤ 8.2	11
6.2 < pH ≤ 6.3	104	7.2 < pH ≤ 7.3	52	8.2 < pH ≤ 8.3	9.4
6.3 < pH ≤ 6.4	101	7.3 < pH ≤ 7.4	46	8.3 < pH ≤ 8.4	7.8
6.4 < pH ≤ 6.5	98	7.4 < pH ≤ 7.5	40	8.4 < pH ≤ 8.5	6.4
6.5 < pH ≤ 6.6	94	7.5 < pH ≤ 7.6	34	8.5 < pH ≤ 8.6	5.3
6.6 < pH ≤ 6.7	89	7.6 < pH ≤ 7.7	29	8.6 < pH ≤ 8.7	4.4
6.7 < pH ≤ 6.8	84	7.7 < pH ≤ 7.8	24	8.7 < pH ≤ 8.8	3.7
6.8 < pH ≤ 6.9	78	7.8 < pH ≤ 7.9	20	8.8 < pH ≤ 8.9	3.1
6.9 < pH ≤ 7.0	72	7.9 < pH ≤ 8.0	17	8.9 < pH ≤ 9.0	2.6

Section NR 106.33(2) was updated effective September 1, 2016. As a result, seasonal 20 and 40 mg/L thresholds for including ammonia limits in municipal discharge permits are no longer applicable under current rules. As such, the table has been expanded from the table in the current permit to include ammonia nitrogen limits throughout the pH range.

Weekly Average & Monthly Average Limits based on Chronic Toxicity Criteria (CTC):

Weekly and monthly average limits based on chronic toxicity criteria for ammonia are also calculated to determine the weekly and monthly average limits to meet the requirements of s. NR 106.07(3).

Weekly average and monthly average limits for ammonia nitrogen are based on chronic toxicity criteria.

The 30-day chronic toxicity criterion (CTC) for ammonia in waters classified for a Cold-water fishery is calculated by the following equation.

$$CTC = E \times \{ [0.0676 \div (1 + 10^{(7.688 - pH)})] + [2.912 \div (1 + 10^{(pH - 7.688)})] \} \times C$$

Where:

pH = the pH (s.u.) of the receiving water,

E = 0.854,

C = the minimum of 2.85 or $1.45 \times 10^{(0.028 \times (25 - T))}$,

T = the temperature (°C) of the receiving water

The 4-day criterion is simply equal to the 30-day criterion multiplied by 2.5. The 4-day criteria are used in a mass-balance equation with the 7-Q₁₀ (4-Q₃, if available) to derive weekly average limitations. And the 30-day criteria are used with the 30-Q₅ (estimated as 85% of the 7-Q₂ if the 30-Q₅ is not available) to derive monthly average limitations. The stream flow value is further adjusted to temperature; 100% of the flow is used if the Temperature ≥ 16 °C, 25% of the flow is used if the Temperature < 11 °C, and 50% of the flow is used if the Temperature ≥ 11 °C but < 16 °C.

Ammonia limits were last calculated in 2013. At that time, default stream pH and temperatures were used to calculate limits. At this time, more specific information is available for both parameters which warrant a re-calculation of weekly and monthly average limits. New default temperature data are available for

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relatively small warm water streams as part of new thermal standards; the new default ambient stream temperatures are contained in Table 2 of ch. NR 102. Seasonal mean pH values are now available for the Bad River in Ashland County. The new ambient values are used in conjunction with the effluent and stream low flows to re-calculate limits using the procedure in s. NR 106.32, Wis. Adm. Code.

		Spring	Summer	Winter
		April & May	June – Sept.	Oct. – March
Effluent Flow	Qe (MGD)	0.205	0.205	0.205
Background Information	7-Q ₁₀ (cfs)	5.4	5.4	5.4
	7-Q ₂ (cfs)	12	12	12
	Ammonia (mg/L)	0.03	0.03	0.025
	Temperature (°C)	11	16	4
	pH (s.u.)	7.69	7.75	7.56
	% of Flow used	25	100	25
	Reference Weekly Flow (cfs)	1.35	5.4	1.35
	Reference Monthly Flow (cfs)	2.55	10.2	2.55
Criteria mg/L	4-day Chronic	9.05	6.85	10.33
	30-day Chronic	3.62	2.74	4.13
Effluent Limits mg/L	Weekly Average	47.42	122.91	54.20
	Monthly Average	32.46	89.85	37.15

Effluent Data

The following table evaluates the statistics based upon ammonia data reported from May 2014 through April 2019, with those results being compared to the calculated limits to determine the need to include ammonia limits in the City of Mellen permit for the respective month ranges. That need is determined by calculating 99th upper percentile (or P₉₉) values for ammonia during each of the month ranges and comparing the daily maximum values to the daily maximum limit. Based on this comparison, daily limits are required year-round.

	Ammonia mg/L April - May	Ammonia mg/L June - September	Ammonia mg/L October - March
1-day P ₉₉	17.3	22.5	20.8
4-day P ₉₉	11.2	13.0	13.3
30-day P ₉₉	8.08	8.17	9.47
Mean	6.61	6.03	7.67
Std	3.19	4.45	3.89
Sample size	43	77	129
Range	<0.08 – 16	0.1 – 24	0.083 – 18

Conclusions and Recommendations:

Where there are existing ammonia nitrogen limits in the permit, the limits are recommended to be retained regardless of reasonable potential, consistent with s. NR 106.33(1), Wis. Adm. Code:

- (b) If a permittee is subject to an ammonia limitation in an existing permit, the limitation shall be included in any reissued permit. Ammonia limitations shall be included in the permit if the permitted facility will be providing treatment for ammonia discharges.

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In summary, a daily maximum ammonia nitrogen limit of 9.4 mg/L is recommended for the City of Mellen. No mass limitations are recommended in accordance with s. NR 106.32(5). Additional limits to meet the expression of limits requirements of ss. NR 106.07 and NR 205.065(7) are discussed in Part 7.

PART 4 –PHOSPHORUS

Technology Based Phosphorus Limit

Wisconsin Administrative Code, ch. NR 217, requires municipal wastewater treatment facilities that discharge greater than 150 pounds of Total Phosphorus per month to comply with a monthly average limit of 1.0 mg/L, or an approved alternative concentration limit.

Because the City of Mellen does not currently have an existing technology-based limit, the need for this limit in the reissued permit is evaluated. The data demonstrates that the annual monthly average phosphorus loading is less than 150 lbs/month, which is the threshold for municipalities in accordance to s. NR 217.04(1)(a)1, and therefore no technology-based limit is recommended.

Month	Average Phosphorus Concentration (mg/L)	Total Effluent Flow (Million Gallons)	Calculated Mass (lbs/month)
January	0.96	10.78	86.4
February	1.1	9.33	85.7
March	1.2	19.15	191.6
April	0.94	16.35	128.2
May	1.0	15.25	127.2
June	1.4	17.69	206.6
July	0.98	14.08	115.1
August	0.78	14.61	95.1
September	0.72	13.21	79.4
October	0.78	13.47	87.6
November	0.86	10.59	76.0
December	1.8	9.77	146.6
Average			112.35

Total P (lbs/month) = Monthly average (mg/L) × total flow (MGD) × 8.34 (lbs/gallon)

Where total flow is the sum of the actual (not design) flow (in MGD) for that month

Water Quality-Based Effluent Limits (WQBEL)

Revisions to administrative rules regulating phosphorus took effect on December 1, 2010. These rule revisions include additions to ch. NR 102 (s. NR 102.06), which establish phosphorus standards for surface waters. Revisions to ch. NR 217 (s. NR 217, Subchapter III) establish procedures for determining water quality based effluent limits for phosphorus, based on the applicable standards in ch. NR 102.

Section NR 102.06(3)(a) specifically names reaches of rivers for which a phosphorus criterion of 0.1 mg/l applies. For other stream segments that are not specified in s. NR 102.06(3)(a), s. NR 102.06(3)(b), Wis. Adm. Code, specifies a phosphorus criterion of 0.075 mg/L. The phosphorus criterion of 0.075 mg/L applies for Bad River.

The conservation of mass equation is described in s. NR 217.13 (2)(a), Wis. Adm. Code, for phosphorus WQBELs and includes variables of water quality criterion (WQC), receiving water flow rate (Qs), effluent flow rate (Qe), and upstream phosphorus concentrations (Cs):

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$$\text{Limitation} = [(WQC)(Q_s + (1-f) Q_e) - (Q_s - f Q_e) (C_s)]/Q_e$$

Where: WQC = 0.075 mg/L for Bad River

Q_s = 100% of the 7- Q_2 of 12 cfs

C_s = background concentration of phosphorus in the receiving water pursuant to s. NR 217.13(2)(d), Wis. Adm. Code

Q_e = effluent flow rate = 0.205 MGD = 0.317 cfs

f = the fraction of effluent withdrawn from the receiving water ($f = 0$)

Section NR 217.13(2)(d), Wis. Adm. Code, specifies that the background phosphorus concentration used in the limit calculation formula shall equal the median of at least four samples collected during the months of May through October, and that all samples collected during a 28-day period shall be considered as a single sample and the average of these concentrations used to determine a median. Averaging begins at date of the first sample in the range of May through October.

A previous evaluation resulted in a WQBEL of 1.9 mg/L using a background concentration of 0.030 mg/L. Section NR 217.13(2)(d) states that the determination of upstream concentrations shall be evaluated at each permit reissuance. Additional data were considered in estimating the background phosphorus concentration.

A review of all available in stream total phosphorus data stored in the Surface Water Integrated Monitoring System database for similar waterbodies indicates the median background total phosphorus concentration in the Bad River at near the discharge is 0.03 mg/L.

	Downstream		
SWIMS ID	10034375	10012906	023129
	Monitoring station	Monitoring station at	
	Upstream Ballou	Hwy 77	Monitoring station at
Station Name	Confluence		East Taylor Bridge
Waterbody	Devils Creek	Tyler Fks	Bad River
Sample Count	8	38	5
First Sample	08/22/2012	08/22/2012	07/28/2007
Last Sample	09/01/2014	10/25/2016	09/26/2007
Mean	0.026	0.031	0.045 mg/L
Median	0.027	0.029	0.047 mg/L
NR 217 Median	0.027	0.031	0.047 mg/L

Substituting a median value of 0.03 mg/L into the limit calculation equation above, the calculated limit is 1.8 mg/L.

Effluent Data

The following table summarizes effluent total phosphorus monitoring data from May 2014 to April 2019.

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	Phosphorus mg/L
1-day P ₉₉	2.5
4-day P ₉₉	1.8
30-day P ₉₉	1.47
Mean	1.28
Std	0.41
Sample size	60
Range	0.63 – 2.3

Reasonable Potential Determination

Since the 30-day P₉₉ of reported effluent total phosphorus data is below the calculated WQBEL, **the discharge does not have reasonable potential to cause or contribute to an exceedance of the water quality criterion.** Therefore, a water quality-based effluent limit is not recommended

PART 5 –THERMAL

In accordance with s. NR 106.53(2)(b), the highest daily maximum flow rate for a calendar month is used to determine the acute (daily maximum) effluent limitation. In accordance with s. NR 106.53(2)(c), the highest 7-day rolling average flow rate for a calendar month is used to determine the sub-lethal (weekly average) effluent limitation. These values were based off actual flow reported from 2014.

The table below summarizes the maximum temperatures reported during monitoring from April to October of 2014. At the latest permit issuance, limits were not determined necessary for November to March and as such, monitoring was not required. Comparing the representative highest effluent temperature to the calculated effluent limits determines the reasonable potential of exceeding the effluent limits. The months in which limitations are recommended are highlighted. The complete thermal table used for calculation is attached.

Month	Representative Highest Monthly Effluent Temperature		Calculated Effluent Limit	
	Weekly Maximum	Daily Maximum	Weekly Average Effluent Limitation	Daily Maximum Effluent Limitation
	(°F)	(°F)	(°F)	(°F)
JAN	-	-	-	-
FEB	-	-	-	-
MAR	-	-	-	-
APR	44	45	73	99
MAY	64	66	73	88
JUN	70	71	82	92
JUL	73	74	78	100

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Month	Representative Highest Monthly Effluent Temperature		Calculated Effluent Limit	
	Weekly Maximum	Daily Maximum	Weekly Average Effluent Limitation	Daily Maximum Effluent Limitation
	(°F)	(°F)	(°F)	(°F)
AUG	74	74	71	99
SEP	64	70	66	96
OCT	51	59	66	120
NOV	-	-	-	-
DEC	-	-	-	-

Reasonable Potential

Permit limits for temperature are recommended based on the procedures in s. NR 106.56.

- An acute limit for temperature is recommended for each month in which the representative daily maximum effluent temperature for that month exceeds the acute WQBEL. The representative daily maximum effluent temperature is the greater of the following:
 - (a) The highest recorded representative daily maximum effluent temperature
 - (b) The projected 99th percentile of all representative daily maximum effluent temperatures
- A sub-lethal limitation for temperature is recommended for each month in which the representative weekly average effluent temperature for that month exceeds the weekly average WQBEL. The representative weekly average effluent temperature is the greater of the following:
 - (a) The highest weekly average effluent temperature for the month.
 - (b) The projected 99th percentile of all representative weekly average effluent temperatures for the month

The limits were given at the last permit issuance subject to drop. An analysis was done in 2014 after the City of Mellen completed the sampling for the months of April to October.

Reasonable Potential

Based on the available effluent data at this and similar facilities **no effluent limits are recommended for temperature at this time.** Effluent thermal monitoring is recommended in the fourth year of the permit term to determine the potential need for limits with new data. If this data results in the need for limits, it is recommended that the facility conduct a dissipative cooling study.

PART 6 – WHOLE EFFLUENT TOXICITY (WET)

WET testing is used to measure, predict, and control the discharge of toxic materials that may be harmful to aquatic life. In WET tests, organisms are exposed to a series of effluent concentrations for a given time and effects are recorded. The following evaluation is based on procedures in the Department's WET Program Guidance Document (revision #11, dated November 1, 2016).

- Acute tests predict the concentration that causes lethality of aquatic organisms during a 48 to 96-hour

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exposure. To assure that a discharge is not acutely toxic to organisms in the receiving water, WET tests must produce a statistically valid LC₅₀ (Lethal Concentration to 50% of the test organisms) greater than 100% effluent.

- According to the *State of Wisconsin Aquatic Life Toxicity Testing Methods Manual* (s. NR 219.04, Table A, Wis. Adm. Code), a synthetic (standard) laboratory water may be used as the dilution water and primary control in acute WET tests, unless the use of different dilution water is approved by the Department prior to use. The primary control water must be specified in the WPDES permit.

The WET Checklist was developed to help DNR staff make recommendations regarding WET limits, monitoring, and other permit conditions. The Checklist steps the user through a series of questions that evaluate the potential for effluent toxicity. The Checklist indicates whether acute and chronic WET limits are needed, based on requirements specified in s. NR 106.08, Wis. Adm. Code, and recommends monitoring frequencies based on points accumulated during the Checklist analysis. As toxicity potential increases, more points accumulate, and more monitoring is recommended to ensure that toxicity is not occurring. The completed WET Checklist recommendations for this permittee are summarized in the table below. Staff recommendations, based on the WET Checklist and best professional judgment, are provided below the summary table. For guidance related to RP and the WET Checklist, see Chapter 1.3 of the WET Guidance Document: <http://dnr.wi.gov/topic/wastewater/WETguidance.html>.

WET Checklist Summary

	Acute	Chronic
AMZ/IWC	Not Applicable. 0 Points	IWC = 14%. 0 Points
Historical Data	Tests used to calculate RP = 0 Tests failed = 0 5 Points	Tests used to calculate RP = 0 Tests failed = 0 5 Points
Effluent Variability	Little variability, no violations 0 Points	Same as Acute. 0 Points
Receiving Water Classification	Full Fish & Aquatic Life 5 Points	Same as Acute. 5 Points
Chemical-Specific Data	Limits for no substances based on ATC; chloride, arsenic, copper, mercury, nickel, and zinc detected. No additional compounds of concern 3 Points	Limits for no substances based on CTC; chloride, arsenic, copper, mercury, nickel, and zinc detected. No additional compounds of concern 3 Points
Additives	0 Biocides and 0 Water Quality Conditioners added. SorbX-100 Used: No 0 Points	All additives not used more than once per 4 days. 0 Points
Discharge Category	Two non-significant Industrial Contributors. 0 Points	Same as Acute. 0 Points
Wastewater Treatment	Secondary or Better 0 Points	Same as Acute. 0 Points
Downstream Impacts	No impacts known 0 Points	Same as Acute. 0 Points

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Total Checklist Points:	13 Points	13 Points
Recommended Monitoring Frequency (from Checklist):	No WET tests recommended	No WET tests recommended
Limit Required?	No	No
TRE Recommended? (from Checklist)	No	No

- Following the guidance provided in the Department's WET Program Guidance Document (revision #11, dated November 1, 2016), based upon the point totals generated by the WET Checklist, other information given above, and Chapter 1.3 of the WET Guidance Document, no WET tests are recommended in the reissued permit.

PART 7 – EXPRESSION OF LIMITS

Revisions to chs. NR 106 and 205, Wis. Adm. Code align Wisconsin's water quality-based effluent limitations with 40 CFR 122.45(d), which requires WPDES permits contain the following concentration limits, whenever practicable and necessary to protect water quality:

- Weekly average and monthly average limitations for continuous discharges subject to ch. NR 210.
- Daily maximum and monthly average limitations for all other discharges. The City of Mellen is a municipal treatment facility, and is therefore subject to weekly average and monthly average limitations whenever limitations are determined to be necessary.

This evaluation provides additional limitations necessary to comply with the expression of limits in ss. NR 106.07 and NR 205.065(7), Wis. Adm. Code. Pollutants already compliant with these rules or that have an approved impracticability demonstration, are excluded from this evaluation including water-quality based effluent limitations for phosphorus, temperature, and pH, among other parameters. Mass limitations are not subject to the limit expression requirements if concentrations limits are given.

Method for calculation:

The methods for calculating limitations for continuous discharges subject to ch. NR 210 to conform to 40 CFR 122.45(d) are specified in s. NR 106.07(3), and are as follows:

- Whenever a daily maximum limitation is determined necessary to protect water quality, a weekly and monthly average limitation shall also be included in the permit and set equal to the daily maximum limit unless a more restrictive limit is already determined necessary to protect water quality.
 - Ammonia Nitrogen:
 - If the pH variable daily maximum limits table is used, the weekly and monthly average limits could be set equal to the highest daily maximum limit of 108 mg/L based on a pH of 6.0. However, the calculated weekly and monthly average limits are recommended as they are more stringent.
 - If the single daily maximum limit of 9.4 mg/L is included, the weekly and monthly average limits would also be 9.4 mg/L year-round.

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2. Whenever a weekly average limitation is determined necessary to protect water quality, a monthly average limitation shall also be included in the permit and set equal to the weekly average limit unless a more restrictive limit is already determined necessary to protect water quality.
3. Whenever a monthly average limitation is determined necessary to protect water quality, a weekly average limit shall be calculated using the following procedure and included in the permit unless a more restrictive limit is already determined necessary to protect water quality:

$$\text{Weekly Average Limitation} = (\text{Monthly Average Limitation} \times \text{MF})$$

Where:

MF= Multiplication factor as defined in Table 1

CV= coefficient of variation (CV) as calculated in s. NR 106.07(5m)

CV = Standard deviation/arithmetic mean,

$$= 1.18 / 2.02 = 0.58 = 0.6 \text{ for Mercury}$$

n= the number of samples per month required in the permit

s. NR 106.07 (3) (e) 4. Table 1 — Multiplication Factor (for CV = 0.6)

CV	n=1	n=2	n=3	n=4	n=8	n=12	n=16	n=20	n=24	n=30
0.6	1.00	1.31	1.51	1.64	1.95	2.12	2.23	2.30	2.36	2.43

Note: This methodology is based on the *Technical Support Document for Water Quality-based Toxics Control* (March 1991). PB91-127415.

Additional limitations needed to comply with s. NR 106.07 Expression of limits:

Parameter	Daily Maximum	Weekly Average	Monthly Average	Weekly Geometric Mean	Monthly Geometric Mean	Multiplication Factor (CV)	Assumed Monitoring Frequency (n)
Ammonia, Nitrogen	Variable			-	-	-	-
April – May		47 mg/L	32 mg/L				
June – September		108 mg/L	89 mg/L				
October – March		54 mg/L	37 mg/L				
Fecal Coliforms	-	-	-	656#/100mL	400#/100mL	1.64 (0.6)	Weekly (4)
Mercury	-	1.3 ng/L	1.3 ng/L	-	-	1.00 (0.6)	Quarterly (1)

Attachment #2



